

## CLAIMS

1. A communication system for achieving end-to-end Quality  
of Service in a mobile network using terminal centric control  
5 comprising:

a terminal with QoS control module that is capable of  
performing QoS monitoring, reporting and enforcement;

a central controller that accepts QoS reports from the  
terminal and gives QoS enforcement instructions to the QoS  
10 control module in the terminal; and

a central database that stores subscription  
information of a user who uses the terminal and service level  
agreement information.

15 2. The communication system according to claim 1, further  
comprising:

a policy control framework that is capable of carrying  
management decision to network nodes for service and QoS  
enforcement; and

20 a security control framework that is capable of  
authenticating the user, authorizing the service and  
resources and collecting accounting information based on the  
user's subscription information.

25 3. The communication system according to claim 1 or 2,

comprising:

means for enforcing network QoS by exchanging information with the policy control framework;

means for managing QoS enforcement of the terminal  
5 based on the user's subscription information and terminal status by retrieving the user's subscription information from the central database;

means for detecting a change of the terminal status;

means for synchronising the terminal status by  
10 updating the user's subscription information in the central database when any status change is detected; and

means for securing the message exchange with the terminal by using security association obtained from the user's subscription information.

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4. The communication system according to claim 1 or 2, comprising:

a local database for storing the QoS information of each terminal;

20 a local database for storing the tunnelling information of each terminal for QoS control and reporting purpose; and

a local database for storing status information of a network where the each terminal is attached.

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5. The communication system according to claim 1 or 2, comprising;

a proxy node that would securely forward messages from the terminal to the central controller in its home domain according to domain information provided by the terminal when the terminal is not directly attached to the home domain; and

a proxy node that would securely forward messages from the central controller to the terminal.

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6. The communication system according to claim 1 or 2, comprising:

a monitoring node in the network where the terminal is attached to that would report network information relevant to the terminal to the central controller; and

an enforcement node in the network where the terminal is attached to that would carry out enforcement command from the central controller to provide service to the terminal.

20 7. The communication system according to claim 1 or 2, wherein the QoS control module in the terminal comprises:

a monitor module that collects QoS information from the terminal and all running applications;

a communication module that reports the collected QoS information to the central controller and receives

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enforcement instructions from the central controller; and  
an enforcement module that regulates a behaviour of  
the terminal according to metrics received through the  
communication module.

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8. The communication system according to claim 7, wherein  
the QoS control module in the terminal further comprises a  
local database for storing the collected QoS information.

10 9. The communication system according to claim 7, wherein  
the monitor module comprises:

means for capturing the QoS information and storing  
the QoS information at a local database in the terminal;

means for monitoring threshold violation; and

15 means for initiating the enforcement module to perform  
traffic regulation when the violation is detected.

10. The communication system according to claim 7, wherein  
the Communication Module comprises:

20 means for packing the QoS information in a known  
format before sending the QoS information to the central  
controller;

means for parsing QoS enforcement information  
received from the central controller;

25 means for updating terminal state based on the QoS

enforcement information received from the central controller; and

means for initiating the enforcement module to perform a relevant correction in the enforcement information  
5 received from the central controller if necessary.

11. The communication system according to claim 7 wherein the enforcement module further comprises means for performing traffic regulation at the terminal in order to  
10 regulate terminal performance.

12. The communication system according to claim 11, wherein the enforcement module comprises at least any one of the following means:

15 means for classifying packets into different priorities within the terminal;

means for managing dropping of packets within the terminal when resource quota allocated to the terminal is used up;

20 means for reducing congestion at the terminal by lowering a transmission rate;

means for reducing congestion at the terminal by delaying transmission of packets when insufficient resource is allocated to the terminal;

25 means for terminating sessions and stopping

transmission of packets;

means for reducing outgoing traffic by limiting total number of outgoing sessions;

means for reducing incoming traffic by limiting total  
5 number of incoming sessions; and

means for reducing incoming traffic by requesting for less incoming traffic.

13. The communication system according to claim 1, wherein  
10 the central database stores;

information on QoS profile of each individual user's subscription information;

information on status of the individual terminal;

information on service agreements between networks;

15 information on status of the network providing service to the terminal; and

information on policy handling mechanism for QoS management.

20 14. A communication method in a communication system, wherein the communication system for achieving end-to-end Quality of Service in a mobile network using terminal centric control comprises a terminal with QoS control module that is capable of performing QoS monitoring, reporting and  
25 enforcement, a central controller that accepts QoS reports

from the terminal and gives QoS enforcement instructions to the QoS control module in the terminal, and a central database that stores subscription information of a user who uses the terminal and service level agreement information,

5 comprising:

a step where the QoS control module collects service and QoS statistics, and feedbacks them to the central controller;

a step where the central controller receives QoS  
10 records from the QoS control modules;

a step where the central controller performs QoS management based on the QoS records from the terminal and its subscription information;

a step where the central controller sends QoS  
15 enforcement rules to the QoS control module for QoS adjustment; and

a step where the QoS control module performs QoS enforcement rules sent from the central controller, and also performs local enforcement decisions within itself.

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15. The communication method according to claim 14, comprising:

a step where the central controller updates the central database about the terminal's status; and

25 a step where the central controller retrieves terminal

information from the central database for QoS management.

16. The communication method according to claim 14, wherein the communication system further comprises a monitoring node  
5 in the network where the terminal is attached to that would report network information relevant to the terminal to the central controller, and an enforcement node in the network where the terminal is attached to that would carry out enforcement command from the central controller to provide  
10 service to the terminal, comprising;

a step where the enforcement node provides service to the terminal to collect network status information regarding the terminal and feedbacks the collected network status information to the central controller;

15 a step where the enforcement node provides service to the terminal to perform local admission control based on local policy;

a step where the central controller performs QoS management and decides QoS enforcement rules based on the  
20 feedback information; and

a step where the enforcement node provides service to the terminal to carry out QoS rules sent from the central controller.

25 17. The communication method according to claim 14,

comprising:

a step where the terminal embeds QoS control capability information in a session control message and sends this information to a session control server during session  
5 initiation;

a step where the central controller initiates a monitor session when the session control server detects the QoS control capability information;

a step where the central controller replies to the  
10 terminal with a QoS control capability embedded in an acknowledgement message; and

a step where the terminal initiates the QoS control module when the acknowledgement message from the session initiation contains the QoS control capability information,  
15 whereby communication channel between the QoS control module in the terminal and the central controller for performing QoS control is established.

18. The communication method according to claim 17,  
20 comprising:

a step where the terminal embeds QoS reporting information in a session control message and sends the information to the session control server using the established communication channel;

25 a step where the session control server parses the QoS

reporting information embedded in the session control message; and

a step where the session control server passes the QoS reporting information to the central controller,

5       whereby the QoS control module reports the QoS information to the central controller.

19. The communication method according to claim 18 further comprising a step where the central controller stores the  
10   QoS reporting information at a back-end database.

20. The communication method according to claim 17, comprising:

a step where the central controller embeds QoS  
15   enforcement information in a session control message and sends it to a session client at the terminal using the communication channel;

a step where the session client parses the QoS enforcement information embedded in the session control  
20   message by session application; and

a step where the session client passes the QoS enforcement information to the QoS control module.

21. The communication method according to claim 20 further  
25   comprising a step where the terminal stores the QoS

enforcement information at the terminal's local database.

22. The communication method according to claim 16, comprising:

5           a step of computing and setting threshold and boundary values for triggering monitoring events at the terminal;  
          a step of triggering violation events when violation is detected at the terminal;

          a step where triggering non-violation events for  
10 non-violation monitoring events at the terminal,  
          whereby the monitoring module of the QoS control module at the terminal performs traffic monitoring.

23. The communication method according to claim 14,  
15 comprising:

          a step where the terminal requests for a QoS control service during the access control process when the terminal attaches to a network;

          a step where the central controller initiates a monitor  
20 session when an access control server informs the central controller of the QoS control service request;

          a step where tunnelling channel information is allocated and embedded into the access control reply by the central controller; and

25           a step where the tunnelling channel information is

received, and the tunnelling channel is set up between the QoS control module at the terminal and the central controller using this information,

whereby communication channel between the QoS control  
5 module in the terminal and the central controller for performing QoS control is established.

24. The communication method according to claim 23, comprising:

10 a step of collecting the terminal's QoS information;  
a step of packing the QoS information into a specified QoS report format; and

a step of sending out the QoS report to the central controller,

15 whereby the QoS control module reports the QoS information to the central controller.

25. The communication method according to claim 24 further comprising a step of storing the collected QoS information  
20 locally at the terminal's local database.

26. The communication method according to claim 23, comprising:

a step where the central controller receives the QoS  
25 report from the terminal;

a step where the central controller compares the QoS report received with QoS profile obtained from the back-end database;

a step where the central controller packs the QoS  
5 feedback information into a specified QoS feedback report format; and

a step where the central controller sends out the QoS feedback report to the terminal,

whereby the central controller feedbacks to the QoS  
10 control module in the terminal.

27. The communication method according to claim 19 or 25, comprising:

a step where the central controller loads the service  
15 user's QoS profile from the back-end database;

a step where the central controller loads the intermediate networks QoS profile from the back-end database;

a step where the central controller obtains the status  
20 of intermediate networks from network's enforcement node;

a step where the central controller obtains the status of the terminal via reporting from communication channels;

a step where the central controller compares the state of the terminal with terminal's QoS profile; and

25 a step where the central controller compares the state

of the network node with the network QoS profile.

28. The communication method according to claim 23, comprising:

5 a step where the central controller decides on actions to be taken based on policy handling mechanism information stored in a back-end database;

a step where the central controller packs action information with relevant QoS parameters into an QoS enforcement message format; and  
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a step where the central controller sends the QoS enforcement message to the QoS control module of the terminal that needs to perform correction.

15 29. A communication method in a communication system, wherein the communication system for achieving end-to-end Quality of Service in a mobile network using terminal centric control comprises a terminal with QoS control module that is capable of performing QoS monitoring, reporting and  
20 enforcement, a central controller that accepts QoS reports from the terminal and gives QoS enforcement instructions to the QoS control module in the terminal, and a central database that stores subscription information of a user who uses the terminal and service level agreement information,  
25 comprising:

a step of computing a threshold value of QoS metrics that needs to be monitored;

a step of performing local QoS adjustment to the terminal if the measurement of the QoS metrics is not within  
5 the valid range of the threshold value as computed;

a step of collecting QoS information and usage and adjustment statistics at the terminal;

a step of sending the QoS information in a predetermined report format to the central controller;

10 a step of receiving of QoS enforcement feedback from the central controller; and

a step of performing correction based on the feedback from the central controller.

15 30. The communication method according to claim 29, comprising:

a step of updating the terminal's local database with the QoS data collected; and

a step of updating the terminal's local database with  
20 the enforcement feedback received from the central controller.

31. The communication method according to claim 29 wherein packet transmission at terminal is delayed for the local QoS  
25 adjustments to the terminal.

32. The communication method according to claim 29 wherein packet is dropped at the terminal for the local QoS adjustments to the terminal.

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33. The communication method according to claim 29 wherein packet transmission rate is reduced at the terminal for the local QoS adjustments to the terminal.

10 34. The communication method according to claim 29 wherein request for receiving channels is reduced at terminal for the local QoS adjustments to the terminal.

15 35. The communication method according to claim 29 wherein transmission/receiving session initiated by the terminal is gracefully self-terminated for the local QoS adjustments to the terminal.

20 36. The communication method according to claim 14, wherein a data format for reporting information from the terminal to the central controller includes:

message ID to distinguish the different incoming messages;

message length to indicate length of the entire message  
25 for reporting status; and

QoS reporting data including attribute value pair that contain the QoS type and its value.

37. The communication method according to claim 14, wherein  
5 a data format for QoS enforcement information from the terminal to the central controller includes:

message ID to distinguish the different incoming messages;

action ID to indicate the action to be carried out;  
10 and

QoS enforcement data that contains parameters associated with the action ID.

38. The communication method according to claim 37,  
15 comprising:

a step of checking the action ID referring a pre-defined template; and

a step of packing or unpacking the QoS enforcement data according to the pre-defined template,

20 whereby the action ID of the QoS enforcement data is encoded and/or decoded.